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National Aeronautics and Space Administration
Office of Biological and Physical Research
Washington, DC 20546

Research Announcement

**Research Opportunities
for
Ground-Based Research
in
Space Radiation Biology
and
Space Radiation Shielding Materials**

**NRA 02-OBPR-02
August 30, 2002**

**NASA Research Announcement Soliciting Research Proposals for
the Period Ending November 25, 2002**

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Research Opportunities for Ground-Based Research in Space Radiation Biology and Space Radiation Shielding Materials

NRA 02-OBPR-02

Summary and Supplemental Information

This National Aeronautics and Space Administration (NASA) Research Announcement (NRA) solicits proposals for ground-based research in space radiation biology and space radiation shielding materials. This research will utilize beams of high-energy heavy nuclei produced at the Booster Applications Facility (BAF) and the Alternating Gradient Synchrotron (AGS) at Brookhaven National Laboratory (BNL). These beams simulate the high-energy, high-charge (HZE) components of galactic cosmic rays that constitute the biologically most significant component of space radiation. BAF is a new \$34 million irradiation facility at BNL, funded by NASA, and expected to start delivering beams for experiments in Fall/Winter of 2003. This research supports NASA's mission and the Office of Biological and Physical Research (OBPR). All participants in this NRA are strongly encouraged to promote general scientific literacy and public understanding of life sciences, the space environment, and the OBPR programs through formal and informal education opportunities. Where appropriate, supported investigators will be required to produce, in collaboration with NASA, a plan for communicating their work to the public (see page B-16).

Proposals for this NRA are due at 4:30 p.m. Eastern time on November 25, 2002. Proposals shall not be submitted electronically, except for parts where this is specified in this NRA. Proposals and notices of intent mailed through the U.S. Postal Service by express, first class, registered, or certified mail are to be sent to the following address:

NASA Peer Review Services
SUBJECT: 02-OBPR-02 Space Radiation Research Proposal
500 E Street SW
Suite 200
Washington, DC 20024

Proposals and notices of intent that are hand delivered or sent by commercial delivery or courier services are to be delivered to the above address between 8:00 a.m. and 4:30 p.m. Proposals must be received by 4:30 p.m. Eastern time on the proposal due date. The telephone number, (202) 479-9030, may be used when required for reference by delivery services. NASA Peer Review Services (NPRS) cannot receive deliveries on Saturdays, Sundays, or federal holidays. NPRS will send notification to the investigator confirming proposal receipt within 5 business days of the proposal receipt date; however, there will not be a response from the Office of Biological and Physical Research.

The following items apply only to this Announcement:

Solicitation Announcement Identifier:	NRA 02-OBPR-02
Number of Copies Required:	Original + 20 copies
Notices of Intent Due:	September 23, 2002
Proposals Due:	November 25, 2002
Estimated Selection Announcement:	March 2003
Selecting Officials:	Directors, Bioastronautics Research Division Fundamental Space Biology Division Physical Sciences Research Division Office of Biological and Physical Research

Safety is NASA's highest priority. Safety is the freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment. NASA's safety priority is to protect: (1) the public, (2) astronauts and pilots, (3) the NASA workforce (including employees working under NASA instruments), and (4) high-value equipment and property. All research conducted under NASA auspices shall conform to this philosophy.

This NRA is organized such that

- Appendix A provides a detailed description of the research areas solicited by this Announcement.
- Appendix B contains specific Instructions for this NRA and relevant application forms and the selection process.
- Appendix C contains copies of the Certifications required with any signed application.
- Appendix D provides reference instructions for responding to NASA Research Announcements.

Proposals submitted in response to this Announcement must address the research emphases defined in this Announcement. Those proposals that do not will be returned to the investigators. **This Research Announcement does not solicit flight research.** Other Announcements calling for focused research or utilization of unique resources may be issued throughout the year. Unsolicited proposals received at other times during the year will be held until the next annual review period if the proposed research is relevant to the programs described in this Announcement. However, NASA reserves the right to act in the best interest of the federal government in the matter of proposal acceptance and evaluation.

Proposals will be funded in one-year increments for activities lasting up to **four** years. The funding duration will depend on proposal requirements, review panel recommendations, and

continuing progress of the activity. All proposals will be evaluated for overall scientific and technical merit by independent peer review panels. Relevance to NASA's programmatic needs and goals will be evaluated separately by NASA. The government's obligation to make awards is contingent upon the availability of appropriated funds from which payment for award purposes can be made, and the receipt of proposals that the government determines are acceptable for award under this NRA. It is anticipated that a typical award will average **\$200,000** per year (total annual cost). The total annual cost for a single ground research grant should not exceed **\$350,000** per year. Proposals for awards greater than these amounts must provide substantial justification. Depending on available funding and the results of peer review for scientific merit, approximately 20 investigations may be selected. NASA reserves the right to return proposals without review that exceed the described award amounts. NASA does not provide separate funding for direct and indirect costs; thus, the amount of the award requested is the total of all costs submitted in the proposed budget. It is estimated that selections will be announced by **March 2003** and grants or contracts awarded shortly thereafter.

Funds are currently available for awards under this NRA only to support research within the Bioastronautics Research Division (BRD) of OBPR. Funds are not currently available for awards under the Fundamental Space Biology (FSB) and Physical Sciences Research (PSR) areas of this NRA. A Radiation Initiative has been submitted to Congress. If approved in the FY 2003 budget (expected October 1, 2002), funds will also become available for research supported by the Fundamental Space Biology (FSB) and Physical Sciences Research (PSR) divisions. The Government's obligation to make award(s) is contingent upon the availability of appropriated funds from which payment can be made and receipt of proposals that NASA determines are acceptable for award under this NRA.

Participation in this Announcement is open to all categories of organizations, industry, educational institutions, other nonprofit organizations, NASA laboratories, and other government agencies. Guidelines for International Participation are detailed in paragraph I of Appendix D of this announcement.

A notice of intent to propose is requested by **September 23, 2002** (see Instructions, Appendix B of this Announcement). Notices of intent should be submitted via the World Wide Web (WWW) at

<http://proposals.hq.nasa.gov/proposal.cfm>

If you do not have access to the WWW, you may submit a notice of intent via e-mail to

noi@hq.nasa.gov

The subject heading of the e-mail message should read "Notice of Intent: SUBJECT: 02-OBPR-02 Space Radiation." If you do not have access to e-mail, you may submit a notice of intent by U.S. Postal Service or commercial delivery to the address listed for proposal submission.

In order to be accepted as a complete submission, proposals must include all information requested in Appendix B. Additional technical information is available from

David L. Tomko, Ph.D.
NASA Headquarters, Code UB
Washington, DC 20546-0001
Telephone: (202) 358-2211
Fax: (202) 358-4168
E-mail: dtomko@hq.nasa.gov

Additional contractual information is available from

NASA Office Of Procurement
Code HS
NASA Headquarters
Washington DC 20546-0001
Telephone: (202) 358-0445

The specific contracting point of contact will be specified in each selection notification letter.

This Announcement is restricted to the program named above and described in detail in Appendix A. Potential investigators should read with care the program descriptions that are of interest and focus their proposals on the specific research emphases defined in this Announcement.

Your interest and cooperation in participating in this effort is appreciated.

Original signed by

Mary E. Kicza
Associate Administrator
Office of Biological and Physical Research

Scientific/Technical Description
Ground-Based Research in Space Radiation Biology and
Space Radiation Shielding Materials

I. Introduction

The major goal of NASA's Space Radiation Research Program within the Office of Biological and Physical Research is to enable the human exploration of space without exceeding limiting risks from space radiation. Space radiation is distinct from terrestrial forms of radiation, being comprised of high-energy protons and heavy ions and their secondaries produced in shielding and tissue. Because there are no human epidemiological data for these radiation types, risk estimation must be derived from mechanistic understanding based on radiation physics, and on molecular, cellular, and tissue radiation biology related to cancer and other risks of concern to NASA. Research to be supported will seek to reduce the uncertainties in risk predictions, including cancer, degenerative tissue damage (e.g., the central nervous system (CNS) and cataracts), hereditary risks, and acute risks, and lead to the development of effective shielding or biological countermeasures to these risks.

Scientists working in rapidly developing areas of life sciences or materials sciences not necessarily associated with the study of radiation are particularly encouraged to consider the contributions that their field of study can make to space radiation research, and to propose relevant investigations. Investigators new to radiation research are encouraged to consult or collaborate with radiation experts in order to develop realistic experimental plans. The background information in this Appendix and the list of references are intended to provide a useful starting point for such scientists as well as for expert radiation researchers not necessarily familiar with the idiosyncrasies of space radiation. Furthermore, NASA scientists are available to assist investigators wishing to enter this field of research.

This Appendix defines the research program and elements encompassed by this Announcement, describes the specific areas of ground-based research that proposals should address, and describes the specific emphases that are acceptable for submission in response to this Announcement. **This NRA does not request proposals for flight research.** It is important that the prospective investigator read the relevant section(s) carefully, as some of the programmatic emphases are different from those appearing in previous Division Announcements. In addition, this NRA includes guidelines for preparing and submitting proposals and defines the administrative policies governing the program and investigators.

II. Research Areas of Interest

Assignment of proposals to any given area of interest will be made as part of the selection process, although investigators are encouraged to supply arguments for categorizing the specific aims listed in their proposed studies. It is expected that most proposals will have “applied” elements as well as “fundamental” elements. Peer review panel evaluations of a given team's strengths or of the relative probability of success of different specific aims in a single proposal may influence how any one proposal is categorized, and programmatic balance may require that applied or fundamental aspects of a given project be emphasized. For these and similar reasons, scientific peer review will be based on the scientific merits and not on programmatic considerations.

Research proposals are expected either to utilize beams of charged particles available at BNL, or to address experimental data obtained with such beams in ways leading to significant predictions that can be tested in future experiments. In FY2003, the beams most likely to be available are those from the AGS, although initial operation of BAF is expected before the end of this period. In subsequent years, the emphasis will be on BAF utilization; AGS beams will continue to be available, but scientific justification for the use of their higher energies will need to be provided. NASA intends to operate these facilities for 600 hours per year if funds are available; selection of beam species and beam energies for experimental running periods will be made by program managers in consultation with scientists proposing experiments for these beams. Investigators selected for funding will need to meet BNL requirements for experiment scheduling in order to gain access to beams and irradiation facilities.

NASA negotiates beam delivery directly with these institutions, and investigators proposing to use these irradiation facilities should not include the cost of beam time in their budgets. However, investigators should include the cost of carrying out the experiments, including travel to these facilities, and provide an estimate of the hours of beam time required to conduct their experiments.

Bioastronautics Research

This area is concerned with the application of mechanistic understanding and mammalian models to achieve significant reductions in the uncertainties in risk projections for cancer, degenerative tissue effects including damage to the CNS, and other health effects caused by space radiation or to develop effective biological countermeasures to these risks. Biological effects of importance include DNA damage processing, signal transduction, cell cycle controls, cellular differentiation, bystander effects, genomic instability, genetic sensitivity or resistance, signal transduction, and persistent oxidative damage. The solicited research will develop approaches to understand the effects of protons and heavy ions as modifiers of these processes. The use of such understanding to develop new transgenic mouse or tissue models improving our ability to extrapolate estimates of cancer and other risks to humans is of high priority. Finally, the development of methods for accurate, quantitative risk prediction is encouraged, both experimentally, in terms of biological predictors of individual radiation risk and theoretically, using appropriate models for quantitative individual risk assessments.

Fundamental Biology

This area is concerned with basic understanding of the effects of the space radiation environment on fundamental biological processes. These include: DNA structural and functional changes caused by radiation, such as mutations and DNA recombination and repair; basic metabolic controls important in biology and known to be modulated by radiation; the cell cycle, especially in relation to cellular repair mechanisms and programmed cell death; mechanisms of tissue and organ response to radiation including signal transduction; and, “bystander” effects and genomic instability. The knowledge gained should have plausible links to Bioastronautics studies directed at estimating risk to astronaut health, and ameliorating negative health effects of space flight. To an appropriate extent, these studies should also lead to quantitative predictions about the interaction of hypergravity, or simulated microgravity, on these mechanisms, that can be subjected to experimental validation.

Physical Sciences Research

This area emphasizes studies of the physics of the interaction of high energy charged particles (HZE) with matter, and development of new insights into the multifunctional use of materials used in space for radiation shielding. Experimental data are available from the work of ongoing NASA-supported measurements of nuclear interaction cross sections and yields, and complementary radiation transport codes are being developed by NASA-supported investigators. The compilation of data into easily accessible formats and the development of 3-dimensional standardized radiation transport codes for use by designers of mission architectures are also priorities in this area. This area of research also supports the Deep Space Test Bed, a balloon-based facility utilized for exposures to galactic cosmic rays reaching down to the top of the Earth atmosphere. No proposals for use of this facility are requested in this solicitation.

III. Research Elements and Emphases

A. Background Information

The following background information is intended to serve as an introduction to concepts essential for an understanding of space radiation research for scientists working in rapidly developing areas of life sciences or materials sciences not necessarily associated with the study of radiation. It is also intended to serve as an overview to scientists familiar with the use of conventional sources of terrestrial radiation, who are interested in extending cutting edge radiation-related research to the problems of space radiation. Further details may be found in the list of references. NASA scientists are available to assist investigators wishing to enter this field of research and all investigators considering a response to this solicitation are encouraged to inquire if the desire to obtain more information. Experienced space radiation investigators may wish to skip this section.

The components of space radiation of greatest biological significance are the highly-charged, energetic heavy ions, also known as HZE particles, present in Galactic Cosmic Rays (GCR). The

biological effects of radiation are a consequence of chemical reactions initiated by energy deposition in cells and tissues. These reactions modify the cell division processes by which cells reproduce as well as other cell functions required for healthy living organisms. Cells have the ability to repair themselves; when that repair is successful, the tissues and organisms return to their normal state. When the repair is not successful, cells may die. If a sufficiently large number of cells are killed, tissue integrity and function may be impaired, as occurs in acute radiation effects. Repair may be successful from the point of view of cell survival, but may contain latent errors that only become manifest in subsequent generations of dividing cells. These errors may also alter the sensitivity of cells to further insults. Eventually, the radiation damage, in conjunction with other stresses, may further alter the cells or their interaction with surrounding tissues, as is assumed to occur during the induction of cancer, leading to delayed health effects.

For the particles composing space radiation, energy deposition is highly localized along the trajectory of each particle. This high rate of energy deposition per unit length of trajectory is the Linear Energy Transfer or LET; the unit generally used in radiobiology is the kilo-electron volt per micrometer, or keV/ μm . The LET of charged particles changes as a function of the particle velocity or kinetic energy. As the velocity (or the energy) of a particle increases, the LET decreases up to a minimum near a velocity of approximately 90% of the speed of light; at higher energies the LET increases very slowly. High-energy charged particles lose energy when they traverse any material. As they slow down, the LET increases to a maximum and then very rapidly decreases to zero. The low-energy maximum in LET occurs very close to the point where the charged particle loses its remaining energy and stops.

GCR particles of average energy can penetrate substantial thicknesses of materials, of the order of several inches of aluminum. If they suffer nuclear interactions, the lighter secondary products will lose energy at a lower rate, and therefore will be able to penetrate even further. For this reason, it is not possible to provide sufficient material to fully absorb all types of radiation in space. In addition, the biological effectiveness of radiation will change as a function of depth of penetration, because the composition of the particles changes and because the LET of each particle changes as it loses energy and slows down inside the material.

Historically, the majority of radiobiological studies have been conducted using x-rays, which have become the standard of comparison and have a very low LET. Higher-LET particles generally require less of a dose than x-rays to induce a given observable biological effect. The quantity used to describe this is the relative biological effectiveness (RBE), which is equal to the ratio of the (generally higher) x-ray dose to the (generally lower) particle dose resulting in the same endpoint. For a multitude of radiation endpoints, the RBE varies significantly as a function of LET. The RBE peaks in the neighborhood of approximately 100 keV/ μm , reflecting the geometry of sensitive targets within the cell. However, above this peak, the effectiveness for most endpoints again decreases, due to the fact that, once a particular endpoint has been achieved, further energy deposition in the damaged sites is wasted.

The characterization of radiation quality in terms of RBE is widely used to describe biological response to radiation, and is also the basis for the regulatory approach that specifies Quality Factors patterned after the LET dependence of RBE. Nevertheless, it is limited to biological endpoints for which a significant response to x-rays can be obtained. When this is not the case,

the ensuing very large values of RBE (“infinite RBE”) may be due to the lack of efficacy of x-rays rather than a particularly effective aspect of the high-LET radiation. The mechanisms and biological effects associated high-LET radiation also may be different from those attributable to x-rays for the same, or similar, macroscopic endpoints. For that reason, the description of radiation action is not complete without an understanding of the processes leading to an observed result.

At the present time, protection against the deleterious health effects of radiation is mainly achieved by limiting access to high radiation environments, controlling the duration of radiation exposure, and by using materials to absorb radiation or degrade its energy. Materials with the smallest mean atomic mass usually are the most efficient shields for the GCR. Except for physical properties and safety considerations, hydrogen would be the best shield. The reasons for this are not immediately apparent, because the absorbed dose from space radiation is delivered by many different kinds of particles, incident on structures in space at a wide range of incident energies. The composition of the radiation field changes as particles lose energy and suffer nuclear interactions while traversing structural materials, instruments, and the bodies of crew members. Both the energy loss and the changes in particle fluence are related to the number of atoms per unit mass (in units such as grams) in the traversed material, which in turn is proportional to Avogadro's number divided by the atomic mass, A , for each element of the material.

The energy loss by ionization of a single component of shielding material with atomic number Z is proportional to the number of electrons per atom and thus proportional to Z/A . However, the energy lost per gram of material and per incident fluence (e.g., in units of particles per cm^2), the “mass stopping power,” is also inversely proportional to the density, d (e.g., in g/cm^3) of the material, so that the energy lost by one incident particle per cm^2 per unit mass is proportional to Z/dA .

The number of nuclear interactions per unit mass and per unit incident fluence is proportional to σ/A , where σ is the total nuclear reaction cross section. To a first approximation, σ is proportional to $A^{2/3}$, so that the nuclear transmission is proportional to $1/A^{1/3}$. The ratio of electronic stopping power to nuclear interaction transmission is thus proportional to $Z/dA^{2/3}$.

Materials with small atomic mass have the highest number of electrons per nucleus (e.g., Z/A is 1 for hydrogen, 0.5 for carbon, but 0.48 for aluminum, 0.46 for iron, and 0.40 for lead). However, light mass materials have smaller nuclei and therefore more of them can fit into a given mass, so that there can be more nuclear interactions. Furthermore, the ratio of ionization energy loss to nuclear interactions is also dependent on the material density. For liquid hydrogen ($d=0.07 \text{ g}/\text{cm}^3$), the ratio is ~ 14 , whereas for aluminum ($d=2.7 \text{ g}/\text{cm}^3$) the ratio is only 0.5, and for lead ($d=11.3 \text{ g}/\text{cm}^3$) the ratio is 0.2.

It is clear from these considerations that a hypothetical shield consisting only of electrons, and thick enough to ensure that a particle loses all its energy inside it (a thickness referred to as the “range” of the particle), would provide ideal shielding characteristics. A close second choice would be a hypothetical shield made of hydrogen, which has the highest ratio of electrons to nuclei per atom. However, while the range of an energetic iron nucleus with an energy of 1

GeV/nucleon (near the peak of the GCR energy spectrum) is approximately 30 cm in water (approximately 10 cm in aluminum), the range of a proton is 12 times greater and a shield intended to stop all particles up to iron would have to be equivalent to 300 cm of water or 100 cm of aluminum. Such thicknesses are not practical, and nuclear reactions will always be a component of shielded radiation fields.

Slowing down incident GCR particles using materials with a preponderance of energy loss due to ionization and a minimum probability of nuclear interactions is not always an optimal strategy. Nuclei such as carbon and oxygen, incident at high energy, have low LET, well beneath the peak value of RBE. When they lose energy in a shielding material (without suffering nuclear interactions), their LET increases. As a consequence, their RBE also increases instead of decreasing, so that they become more hazardous, rather than less hazardous. On the other hand, the LET of incident, high-energy heavier nuclei, such as iron, is close to the 100 keV/ μ m corresponding to the peak RBE. Losing energy and slowing down further increases their LET beyond the peak, making them less hazardous rather than more hazardous.

Conversely, nuclear interactions that change a penetrating GCR nucleus into lighter pieces, e.g., nuclear interactions that fragment silicon into carbon and helium-4 pieces (alpha particles) result in particles of lower RBE, the desired outcome. On the other hand, the fragmentation of high-LET iron into lower-LET chromium or silicon fragments would change the contribution to the radiation field from less hazardous particles, beyond the RBE peak, to more hazardous particles with an LET at or before the peak..

The character of these interactions is also important. Lighter nuclei have fewer neutrons to release and some nuclei, e.g., carbon, can break into three helium nuclei without releasing any neutrons. For very thick shields, lighter nuclei are also more effective in shielding against the built up neutrons. For these and related reasons, detailed knowledge of the actual composition of the radiation fields (and of the biological consequences of exposure to them) is required to evaluate the net effect of shielding materials.

B. Description of Research Elements

Because there are no human epidemiological data for space radiation, the basis for risk estimation must be derived from mechanistic understanding. Research to be supported will seek to reduce the uncertainties in risk predictions, including cancer, degenerative tissue damage (e.g., the central nervous system (CNS) and cataracts), hereditary risks, and acute risks, and lead to the development of effective shielding or biological countermeasures to these risks.

Studies may include animals (including humans), plants, tissues, or cells. Researchers should use the species most appropriate for their research and are encouraged to take advantage of functionally characterized transgenic and mutant species as well as comparative biology approaches that enhance the research scope. Note that assurance of compliance with applicable federal regulations regarding human subjects or animal care and use is required as part of the proposal submission process (see the “Special Matters” instructions in Appendix B).

Investigators are encouraged to review summaries of the research currently funded in this

program by accessing the NASA Office of Biological and Physical Research (OBPR) Tasks and Bibliography (OBPR Task Book) at http://research.hq.nasa.gov/code_u/code_u.cfm.

To be responsive to this research solicitation, proposed studies should be hypothesis-driven and lead to new knowledge within accepted scientific standards. Purely phenomenological approaches with no significant mechanistic basis or likely gain in scientific knowledge are not acceptable.

Experimental studies not directly using the irradiation facilities at BNL or not directly relevant to improved interpretation of experiments already conducted with such radiation will not be funded.

Proposals are required to provide evidence for expertise in radiation, either by reference to the Principal Investigator's work or by the inclusion of active collaborators expert in radiation research.

Proposals should take into account the impact of gender, age, nutrition, stress, genetic predisposition, or sensitivity to other factors of importance in managing space radiation risks.

Proposals addressing issues of relevance to the Bioastronautics areas of interest must represent questions and priorities enumerated in the Critical Path Roadmap, which can be found online at the following internet location: <http://criticalpath.jsc.nasa.gov/main.asp>.

C. Research Emphases for FY 2003

The following are high-priority research topics for FY2003:

1. **DNA mutagenesis and recombination:** Genetic mutations played a critical role in the evolution of life forms on Earth (and perhaps our universe) and are known to participate in or cause cancer formation. This research component will seek to develop or apply fundamental knowledge of DNA mutagenesis and DNA recombination in order to advance our understanding of the molecular basis for mutation in transcribed and non-transcribed DNA after exposure to space radiation components.
2. **Molecular radiation biology of carcinogenesis:** Improving estimates of cancer risks from space radiation using genetic- and molecular-based animal or tissue models, and developing the knowledge needed to use such models to project risks in humans, are priority research areas. This research component will seek to understand the molecular mechanisms of carcinogenesis by protons and HZE particles, including the development of new experimental models of radiation-induced cancers. Research whose primary goal is to measure tumor induction by radiation is not being considered at this time.
3. **CNS radiobiology:** This topic addresses the development of the understanding needed to estimate the risk of degenerative tissue diseases, especially the short term and long term consequences of central nervous system (CNS) irradiation by HZE particles. General questions to be answered include the following: Are the deleterious effects that are

observed in cancer patients receiving high dose gamma irradiation to the CNS observed when rodents are irradiated by HZE particles? What are the cellular and molecular mechanisms of damage to the CNS following irradiation by HZE particles? What morphological changes occur?

4. **Individual genetic susceptibility:** This topic addresses individual-based approaches to risk projections, including the understanding of genetic sensitivity and resistance, and the development of molecular markers of carcinogenesis and/or cancer risk that will allow NASA to project the individuals' risk to space radiation.
5. **Discovery of biological countermeasures:** This topic addresses the development of molecular understanding and identification of targets for risk assay development and intervention leading to discovery of successful biological countermeasures from space radiation.
6. **Novel radiation shielding materials:** This topic addresses the development of novel radiation shielding materials containing light nuclei and hydrogen such as polyethylene and lithium hydride, compounds and absorbing materials containing high atomic ratios of hydrogen, and simulations of planetary regolith material either in raw form or processed for eventual *in situ* use as a construction material. Some of these materials, e.g., carbon nanomaterials, metal hydrides, and palladium/silver alloys, are already under study by groups examining renewable and clean energy sources. In the development of novel shielding materials properties enabling multiple functions, possible hazards and their mitigation, and potential ease of manufacture/fabrication and costs must be considered. Proposals for new shielding materials must provide results of radiation transport codes justifying their intended use as an alternative to polyethylene as a minimum standard of shielding performance.
7. **Multifunctional spacecraft materials:** Some materials that are not optimum for shielding alone may have a multiple function, such as high strength or hydrogen storage. Multifunctional materials must either be known spacecraft materials or permit substitution for one or more spacecraft materials. Multifunctional materials that are proposed for supplementary shielding must be evaluated for their effectiveness, first by using the radiation transport codes, and then by measurement at particle accelerators.

IV. Ground Facilities Description

A. Ground-Based Radiation Accelerator Facilities

NASA has signed agreements with Loma Linda University (LLU) Medical Center related to the use of proton beams, and with Brookhaven National Laboratory for the use of heavy ion beams at the Alternating Gradient Synchrotron. This NRA solicits proposals for research at BNL only; information about LLU is provided because proton irradiations have constituted an important component of the broader research program, and investigators may have reason to seek access to proton beams for preliminary results or comparison with existing data.

NASA has signed Memoranda of Agreement (MOA) with two ground-based laboratories where energetic beams of protons and high-energy heavy ions are available; in particular, proton beams at the **Loma Linda University Medical Center** (protons with energies between 70 MeV and 250 MeV) and the Alternating Gradient Synchrotron (AGS) at **Brookhaven National Laboratory** (beams of iron and other heavy nuclei, with energies as low as 600 MeV/nucleon, up to 10 GeV/nucleon). A new facility at Brookhaven, the Booster Applications Facility (BAF), is under construction. It is expected to become operational in 2003 and will deliver beams of protons and heavy ions ranging up to gold, at energies between tens and thousands of MeV/nucleon. The BAF includes irradiation stations, beam controls, and laboratory facilities required for most radiobiological investigations. Delivery of beam time at the Brookhaven facility has been directly funded by a contract between NASA and Brookhaven, and similar arrangements are intended for use of beam time at Loma Linda University Medical Center.

Brookhaven National Laboratory

The AGS machine is a U.S. Department of Energy (DOE) facility that is funded by the DOE primarily for research in high-energy particle and nuclear physics. Brookhaven is allowed by the DOE to provide additional AGS beam time to other scientific users of the machine, as long as operating funds are provided by the sponsor of such proposed work. Use of the Brookhaven facilities requires a separate proposal, which is reviewed by a laboratory-appointed panel and is scheduled in accordance with available beam time and other laboratory resources. Once experiments are approved, they are required to satisfy the normal process of preparation for running at the AGS, which includes familiarization with AGS rules and policies (safety being the paramount consideration among these) and registration with the laboratory as a guest scientist.

User facilities have been developed at Brookhaven for radiation biology research, including cell cultures and small animals. These include the shielding cave containing the beam, the biological experiment station, and laboratory space and animal facilities in the Brookhaven Medical Department. A 10-ft long optical bench for sample exposures is available in the cave, as well as beam handling, sample changing, and dosimetry instrumentation. The biological experiment station contains one area for cell culture equipped with a laminar flow hood and incubator, one short-term animal holding facility, and one area for physics/run-control use. In addition, laboratory space and access to animal facilities accredited by the Association for Assessment and Accreditation of Laboratory Animal Care are available in the Medical Department, subject to

standard use charges. Brookhaven also has on-site housing accommodation for users (dormitory and apartment-style units).

Iron (^{56}Fe) beams at 600 MeV/nucleon and at 1 GeV/nucleon, as well as ^{28}Si and ^{79}Au , have been used for experiments to date; investigators who need to use other beams or energies should contact the Brookhaven liaison scientists listed below. Normally, circular beam spots are provided, with diameters up to 10 cm and center-to-edge uniformity between 10% and 20% (depending on dose rate—high dose rate beams are less uniform than low-dose rate beams). Dose rates have been measured up to 11 Gy/min. Investigators currently funded by the NASA program participate in research using these beams, and coordination of beam use with these investigators and institutions is actively encouraged. In particular, a physics and dosimetry group is available for investigators requiring their assistance.

The Booster Applications Facility (BAF) is an accelerator facility that provides ions from protons to gold in the energy range of 40-3000 mev/nucleon. It is a synchrotron placed between the Van de Graaff injectors and the higher energy AGS. The BAF is a joint effort of the collider-accelerator department, providing accelerated ion beams; the BNL Biology department, providing experimental area support; and the Medical department, which provides animal care facilities and cell laboratories. It is expected to become operational in Fall of 2003.

For further information regarding Brookhaven National Laboratory, contact Dr. Marcelo Vazquez (e-mail: vazquez@bnl.gov), Dr. Betsy Sutherland (e-mail: betsy@image.bio.bnl.gov), or Dr. Phil Pile (e-mail: pile@bnldag.ags.bnl.gov). The address is Brookhaven National Laboratory, PO Box 5000, Upton, NY 11973-5000. Information about this facility is also available at http://bnlstb.bio.bnl.gov/biodocs/nasa/nasa_ags.htmlx.

Loma Linda University

Loma Linda University operates a facility for treatment of cancer and other diseases, using accelerated protons from a synchrotron located within the medical center. Associated with the synchrotron are treatment rooms and all clinical services relevant to radiation therapy. Also associated with the synchrotron are an experimental area (“research room”), which can receive a proton beam, and an adjacent staging laboratory from which the accelerator can be operated and experiments may be configured prior to irradiation. Close to the accelerators is the new Chan Shun Pavilion, a wing of a research building whose first floor has been designated for a radiobiology research program with capabilities for modern cellular, molecular, and *in vivo* biology studies. Included in this structure is a laboratory dedicated for the use of visiting scientists whose research requires access to proton beams.

The basic beam line was designed to bring protons with energies ranging from 40 MeV to 250 MeV to the research room for experimental work while not interfering with patient treatments. The beam line will provide for flexible delivery of proton beams at doses, dose rates, energies, field sizes, and field uniformities that are adequate for many biology, physics, and materials science experiments. A Co-60 irradiator has been installed to provide gamma rays for control experiments.

For further information regarding the Loma Linda University Medical Center, contact Dr. Gregory A. Nelson (telephone: 909/478-8366; e-mail: gnelson@lluci.llu.edu), Director, Radiobiology Program, Loma Linda University Cancer Institute, 11360 Mt. View Avenue, Hartford Building Suite B, Loma Linda, CA 92354. A description of the facilities at Loma Linda University Medical Center is available at <http://www.llu.edu/proton/patient/overview/hightech.html>.

Consult http://research.hq.nasa.gov/code_u/nra/current/NRA-01-OBPR-06/index.html for instructions on how to incorporate the use of these facilities into a proposal. These instructions must be followed in order to access the facilities.

V. Flight Facilities Description

As flight proposals are not being solicited in this Announcement, descriptions of the flight facilities are not included.

VI. Other Technical Information

For additional information about NASA and its mission and goals, please visit <http://www.nasa.gov/>. For additional information about the Office of Biological and Physical Research, please visit <http://spaceresearch.nasa.gov/>.

Application Procedures and Selection Process

Except where specifically stated otherwise in this NRA, applicants must prepare proposals in accordance with the “Instructions for Responding to NASA Research Announcements,” which is part of the NASA Federal Acquisition Regulations (FAR) Supplement (NFS), Part 1852.235-72 (APPENDIX D).

I. Instructions for Notices of Intent and Proposal Submission

A. SYS-EYFUS Registration

SYS-EYFUS is an electronic system used by NASA Headquarters to manage research solicitation activity, plan for the receipt of research proposals, track the receipt and peer evaluation of these proposals, and manage funded research (grants, cooperative agreements, etc.) sponsored by NASA’s Office of Equal Opportunity (Code E), Office of Earth Science (Code Y), Office of Human Resources & Education Division (Code F), Office of Biological and Physical Research (Code U), Office of Space Science (Code S), and the Office of Space Flight (Code M). SYS-EYFUS also supports the funding and administration of awards pursuant to selection of these research opportunities.

The SYS-EYFUS Help Desk is available at (202) 479-9376. Help desk hours are from 8 a.m. to 6 p.m. Eastern time.

All investigators planning to submit a proposal to this solicitation are requested to register online with SYS-EYFUS. Comprehensive help, instructions, and contact information are provided online. SYS-EYFUS can be accessed at the following Web address:

<http://proposals.hq.nasa.gov/proposal.cfm>

If you have previously registered with SYS-EYFUS, you are asked to verify and update your user information. If you have forgotten your user ID or password, select the “Forgot Your Password” option and type in your first and last name to search our database. The system will send an automatic e-mail message with your username and password to the e-mail address listed in our database.

B. Instructions for Preparing a Notice of Intent

All investigators planning to submit a proposal in response to this solicitation are requested to submit a **non-binding** notice of intent (NOI) to propose by the due date identified in the Summary and Supplemental Information Section of this NRA via the Web at the following address:

<http://proposals.hq.nasa.gov/proposal.cfm>

- 1) Login to SYS-EYFUS at the URL listed above and select “New Notice of Intent.”
- 2) The Division Specific Opportunities screen will appear. In the selection window, highlight **Bioastronautics Research Division** and click on “Continue.”
- 3) The List of Existing Opportunities screen will appear. In the selection window, highlight **02-OBPR-02** and then click on “Continue.”
- 4) This will bring you to the Notice of Intent Submission Form. **All fields are required.**
 - a. Please select from **only** the following three options: For the proposal type field on this form, new / no prior support means that the investigator has not received NASA funding from 1999 through 2001, new / prior support means that the investigator has received NASA funding between 1999 through 2001, and revised means that the proposal is a revised version of a proposal submitted to NASA and reviewed from 1999 through 2001, but not funded. A proposal previously submitted but not funded should be identified as being “revised” even if the original Principal Investigator has changed.
- 5) Click on “Submit NOI Page.”
- 6) The Team Member Page screen will appear, where you can add or remove team members. Select continue if there are no other team members. To add a team member, highlight the role option on the selection list, type in first and last name and click on search... When the resulting set appears, choose the appropriate radio button and click on ADD to add the person to the NOI. After you are done, click on “Continue.” **IMPORTANT:** If the team member is not listed in our database, please have them add themselves as a new user to the system. You may then add them to your team member list.
- 7) After continuing from the Team Members Page, your NOI will be displayed. Click on “Resubmit NOI Page” to complete your NOI submission.
- 8) You may edit and resubmit your NOI at any time before the submission deadline of September 23, 2002. Once you submit an NOI, it cannot be deleted, only edited. For title, team member, or any other changes, please edit your existing NOI and resubmit changes to avoid duplicate records.

C. Instructions for Preparing and Electronically Submitting a Proposal Cover Page

All investigators planning to submit a proposal in response to this solicitation must electronically submit proposal cover page information online and provide a hardcopy of the cover page attached to each proposal copy by the due date indicated in the Summary and Supplemental Information Section of this NRA. The proposal cover page can be submitted and printed via the Web at the following address:

<http://proposals.hq.nasa.gov/proposal.cfm>

- 1) Login to SYS-EYFUS at the URL listed above.
- 2) To submit a New Proposal Cover Page, click the “New Proposal Cover Page” option on the SYS-EYFUS Options screen, and the New Proposals Cover Page screen will appear.
- 3) If you previously submitted an NOI in response to this solicitation, choose to carry over the existing NOI. This option will populate the cover page fields with the NOI information. Edit the information as necessary, click “Continue,” and proceed to #8 below.
- 4) If you did not previously submit an NOI, click on New Proposal Cover Page option, and the Division Specific Opportunities screen will appear.
- 5) In the selection window, highlight **Bioastronautics Research Division** and click on “Continue.”
- 6) The List of Existing Opportunities screen will appear. In the selection window, highlight **02-OBPR-02** and then click on “Continue.”
- 7) This will bring you to the Proposal Cover Page Submission Form. Fill in all the fields. All fields are required.
 - a. Please select from **only** the following three options: For the proposal type field on this form, new / no prior support means that the investigator has not received NASA funding from 1999 through 2001, new / prior support means that the investigator has received NASA funding between 1999 through 2001, and revised means that the proposal is a revised version of a proposal submitted to NASA and reviewed from 1999 through 2001, but not funded. A proposal previously submitted but not funded should be identified as being “revised” even if the original Principal Investigator has changed.
 - b. Indicate the status of IRB/IACUC for your proposal. If IRB or IACUC review is

unavoidably delayed beyond the submission of the application, enter “Pending” on the Proposal Cover Page, and be advised that the certification must be received within 90 days after the due date for which the application is submitted.

Click on “Continue.”

- 8) The Team Member Page screen will appear, where you can add or remove team members. Select “Continue” if there are no other team members. To add a team member, highlight the role option on the selection list, type in first and last name and click on search. When the resulting set appears, choose the appropriate radio button and click on ADD to add the person to the proposal. After you are done, click on “Continue.”

You must include your authorizing official as a team member.. When you complete and print the proposal cover page, you will see signature blocks both for yourself and your authorizing official. You are required to submit one original signed (by both you and your authorizing official) cover page with your proposal hardcopies.

IMPORTANT: If the team member is not listed in our database, please have them add themselves as a new user to the system. You may then add them to your team member list.

- 9) After continuing from the Team Member Page, the Proposal Options Page appears.
- 10) Please fill out the budget form by clicking on the “Budget” button, filling in project costs, and clicking “Continue.” This will bring you to the Proposal Budget Review Page. Click “Continue” if the information is correct.
- 11) After verifying your budget information, you will be returned to the Proposal Options Page. Click the “Show/Print” button.
- 12) For detailed budget information, you may use your own forms or download template forms located at http://research.hq.nasa.gov/code_u/nra/current/NRA-02-OBPR-02/index.html. These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.
- 13) At the page entitled Proposal Information Item List, click “Continue” to preview your Proposal Cover Page. Print the cover page from your Internet browser once you have reviewed the information. The cover page must be signed by both the Principal Investigator and the authorizing official and attached to the front of your proposal before submission of hard copies to NASA.

By signing and submitting the proposal identified on the cover sheet, the Authorizing Official of the proposing institution (or the individual investigator if there is no proposing institution): 1) certifies that the statements made in the proposal are true and complete to the best of his/her knowledge; 2) agrees to accept the obligations to

comply with NASA Award terms and conditions if an award is made as a result of this proposal; 3) provides certification to the following that are reproduced in their entirety in Appendix D of this NRA: (i) Certification Regarding Debarment, Suspension and Other Responsibility matters, (ii) Certification Regarding Lobbying, and (iii) Certification of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs.

- 14) You may edit and resubmit your proposal cover page at any time before the submission deadline as indicated in the Summary and Supplemental Information Section of this NRA.. Please note that once you submit a proposal cover page, it can only be edited, not deleted. For title, team member, budget or any other changes, please edit your existing proposal cover page and resubmit changes to avoid duplicate records.

D. Instructions for Preparation and Delivery of Proposals

All proposals submitted must include the completed cover page form as described in this Appendix. The name of the Principal Investigator should appear in the upper right hand corner of each page of the proposal, except on the cover page form, where special places are provided for this information. Note that the proposal must specify the period of performance for the work described; periods of performance may be for any duration up to the maximum duration identified in the Announcement section of this NRA but should be suitable for the project proposed.

The proposal must include the following material, in this order:

- (1) Proposal Cover Page: Solicited Proposal Application, including certification of compliance with U.S. code (if applicable). One signed original required. Please see “Instructions for Preparing and Electronically Submitting a Proposal Cover Page” (Appendix B, Section I, Part C) for instructions on how to complete the proposal cover page information.
- (2) Transmittal Letter or Prefatory Material, if any (see “Instructions for Responding to NASA Research Announcements” for details)
- (3) Proposal Title Page, with Notice of Restriction on Use and Disclosure of Proposal Information, if any (see “Instructions for Responding to NASA Research Announcements,” for details)
- (4) Project Description

The length of the Project Description section of the proposal cannot exceed 20 pages using regular (12 point) type. Text must be printed on one side only and should have the following margins: left = 1.5”; Right, top, bottom = 1.0”... Referenced figures must be included in the 20 pages of the Project Description. The Bibliography section is not considered part of the 20-page project description. Proposals that exceed the 20-page limit for the project description (22-page limit for revised

proposals; see below) will not be reviewed. The proposal should contain sufficient detail to enable reviewers to make informed judgments about the overall merit of the proposed research and about the probability that the investigators will be able to accomplish their stated objectives with current resources and the resources requested. In addition, the proposal should clearly indicate the relationship between the proposed work and the research emphases defined in this Announcement. Reviewers are not required to consider information presented as appendices or to view and/or consider Web links in their evaluation of the proposal.

New applications where the investigator has received NASA funding in related fields from 1999 through 2001: Results and evidence of progress of the associated NASA supported research must be presented as part of the project description. See “Instructions for Responding to NASA Research Announcements” for details.

Revised applications (revisions of 1999, 2000 or 2001 submissions) must be so designated on the proposal cover page and explained in the project description. This explanation should be presented in a separate section of **no more than two pages at the beginning of the project description**, and is in addition to the 20 pages allowed for the project description. Related changes to the research plan should be highlighted in the body of the project description. Changes within the proposal may be highlighted by appropriate bracketing, indenting, or changing of typography. Clearly present any work done since the prior version was submitted. **Revised applications that do not address the criticisms in the previous review will be considered non-responsive and will be returned without review.** See “Instructions for Responding to NASA Research Announcements” for additional information.

(5) Management Approach

Each proposal must specify a single Principal Investigator who is responsible for carrying out the proposed project and coordinating the work of other personnel involved in the project. In proposals that designate several senior professionals as key participants in the research project, the management approach section should define the roles and responsibilities of each participant and note the proportion of each individual’s time to be devoted to the proposed research activity. The proposal must clearly and unambiguously state whether these key personnel have reviewed the proposal and endorsed their participation.

Co-PIs are not permitted with the sole exception when a non-U.S. Co-Investigator is proposed. This exception is described in the Co-Investigator subcategories below.

Investigators are strongly encouraged to identify only the most critically important personnel to aid in the execution of their proposals. Should such positions be necessary, Co-Investigators (CO-Is) may be identified who are critical for the successful completion of research through the contribution of unique expertise and/or capabilities, and who serve under the direction of the PI, regardless of whether or not they receive compensation under the award. Most NRAs require a Co-I to have a

well-defined role in the research that is defined in the Management section of the proposal. Evidence of a Co-I's commitment to participate is often requested through a brief letter to be included with the proposal.

There are three subcategories of Co-Is that a proposal may identify, as appropriate:

- A Co-I may be designated as the Science PI for those cases where the proposing institution does not permit that individual to formally serve as the PI as defined above. In such a case, the Science PI will be understood by NASA to be in charge of the scientific direction of the proposed work, although the formally designated PI is still held responsible for the overall direction of the effort and use of funds.
- A Co-I may be designated as an Institutional PI when their institution is making a major contribution to a proposal submitted by a PI from another institution.
- A Co-I from a non-U.S. institution may be designated as a Co-Principal Investigator (Co-PI) should such a designation serve required administrative purposes in that Co-I's institution and/or for the procurement of funding by that Co-I from their sponsoring funding authority.

Additional category positions are often included in proposals as defined as follows:

A Postdoctoral Associate holds a Ph.D. or equivalent degree and is identified as a major participant in the execution of the proposed research. Such personnel may be identified by name or only by function in those cases where their recruitment depends on the successful selection of the proposal.

Other Professional is a description appropriate for personnel who support a proposal in a critical albeit intermittent manner, such as a consulting staff scientist or a key Project Engineer and/or Manager, who is not identified as a Co-I or Postdoctoral Associate.

A Graduate Student included in a proposal is working for a post-graduate degree and will support the proposed research under direction of the PI. Such a student may be identified by name or only by function in case their recruitment depends on the successful selection of the proposal.

A Collaborator is an unfunded position included in a proposal, whose participation is less critical than a Co-I, but who is committed to provide a specific contribution to the proposal

(6) Personnel/Biographical Sketches

The biographical sketch for each investigator should not exceed two pages. If the list of qualifications and publications exceeds two pages, select the most pertinent

information (see “Instructions for Responding to NASA Research Announcements” for details). A sample biographical sketch form can be downloaded at http://research.hq.nasa.gov/code_u/nra/current/NRA-02-OBPR-02/index.html. These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.

- (7) Facilities and Equipment (see “Instructions for Responding to NASA Research Announcements” for details)
- (8) Special Matters (specific information on animal or human subjects protocol approval required, if applicable)

For proposals employing human subjects and/or animals, assurance of compliance with human subjects and/or animal care and use provisions is required on the Proposal Cover Page. In addition, the application must include a statement from the applicant institution certifying that the proposed work will meet all Federal and local human subjects requirements and/or animal care and use requirements.

Policies for the protection of human subjects in NASA sponsored research projects are described in NASA Management Instruction (NMI) 7100.8B (*Protection of Human Research Subjects*). Animal use and care requirements are described in the NASA Code of Federal Regulations (CFR) 1232 (*Care and Use of Animals in the Conduct of NASA Activities*). Both documents are available from the Office of Biological and Physical Research, Code UB, NASA Headquarters, Washington, DC 20546.

Additional Requirements for Research Employing Human Subjects

A letter signed by the Chair of the Institutional Review Board (IRB) identifying the proposal submitted to NASA by title and certifying approval of proposed human subjects protocols and procedures should be included with each copy of the proposal. IRB certifications for other research proposals or grants cannot be substituted (even if they employ the same protocols and procedures).

If IRB certification is pending on the proposal due date, select “pending” from the IRB/IACUC section menu on the Proposal Cover Page, and include with each copy of the proposal a letter signed by the IRB Chair identifying the proposal by title and indicating the status of the IRB review process at the time of submission. IRB certification must be received no later than 90 days after the proposal due date. An application lacking the required IRB certification 90 days after the proposal due date will be considered incomplete and may be returned to the applicant without review.

With regard to research involving human subjects, NASA and the NSBRI have adopted the National Institutes of Health (NIH) policy. Women and members of minority groups and their subpopulations must be included in NASA-supported biomedical and behavioral research projects involving human subjects, unless a clear

and compelling rationale and justification is provided showing that inclusion of these groups is inappropriate with respect to the health of the subjects or the purpose of the research.

NASA will require current IRB certification prior to each year's award.

Additional Requirements for Research Employing Animals

Specific information describing and justifying the use of animal subjects must be included in the proposal.

A letter signed by the Chair of the Institutional Animal Care and Use Committee (IACUC) identifying the proposal submitted to NASA by title and certifying approval of the proposed animal research protocols and procedures should be included with each copy of the proposal. The institution's Public Health Service Animal Welfare Assurance Number must be included on the IACUC certification and entered in the IRB/IACUC section of the Proposal Cover Page. IACUC certifications for other research proposals or grants cannot be substituted (even if they employ the same protocols and procedures).

If IACUC certification is pending on the proposal due date, select "pending" from the IRB/IACUC selection menu on the Proposal Cover Page, and include with each copy of the proposal a letter signed by the IACUC Chair identifying the proposal by title and indicating the status of the IACUC review process at the time of submission. IACUC certification must be received no later than 90 days after the proposal due date. An application lacking the required IACUC certification 90 days after the proposal due date will be considered incomplete and may be returned to the applicant without review.

NASA will require current IACUC certification prior to each year's award.

(9) Detailed Budget

For detailed budget information, you may use your own forms or download template forms located at http://research.hq.nasa.gov/code_u/nra/current/NRA-02-OBPR-02/index.html. These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.

NASA is expected to be operating on the basis of full cost accounting as soon as possible, including all Civil Service salaries with overhead. In the interim period, proposals should use the accounting method authorized at their institutions at the time proposals are due and for the entire proposed period of performance. Funds to support the Resident Research Assistant (RRA) Postdoctoral Program costs (e.g., stipend, travel, computer time, supplies, etc.) are to be budgeted within the NASA intramural Principal Investigator budget.

If travel is planned, the proposal budget should include appropriate travel funds for visits to NASA field centers (as appropriate) and presentation of findings at professional society meetings.

(10) Supporting Budgetary Information

In this solicitation, the terms “cost” and “budget” are used synonymously. Sufficient proposal cost detail and supporting information are required; funding amounts proposed with no explanation (e.g., Equipment: \$1,000, or Labor: \$6,000) may cause delays in evaluation and award. Generally, costs will be evaluated for realism, reasonableness, allowability, and allocation. The budgetary forms define the desired detail, but each category should be explained in this section. Offerors should exercise prudent judgment in determining what to include in the proposal, as the amount of detail necessarily varies with the complexity of the proposal.

The following examples indicate the suggested method of preparing a cost breakdown:

Direct Labor

Labor costs should be segregated by titles or disciplines with estimated hours and rates for each. Estimates should include a basis of estimate, such as currently paid rates or outstanding offers to prospective employees. This format allows the Government to assess cost reasonableness by various means including comparison to similar skills at other organizations.

Other Direct Costs

Please detail, explain, and substantiate other significant cost categories as described below:

- Subcontracts: Describe the work to be contracted, estimated amount, recipient (if known), and the reason for subcontracting.
- Consultants: Identify consultants to be used, why they are necessary, the time they will spend on the project, and the rates of pay.
- Equipment: List separately. Explain the need for items costing more than \$5,000. Describe basis for estimated cost. General-purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested as a direct charge must include the equipment description, how it will be used in the conduct of the basic research proposed, and why it cannot be purchased with indirect funds.
- Supplies: Provide general categories of needed supplies, the method of acquisition, and estimated cost.
- Travel: Describe the purpose of the proposed travel in relation to the grant, and provide the basis of estimate, including information on destination and number of travelers (if known).

- Other: Enter the total of direct costs not covered by a) through e). Attach an itemized list explaining the need for each item and the basis for the estimate.

Indirect Costs

Indirect costs should be explained to an extent that will allow the Government to understand the basis for the estimate. Examples of prior year historical rates, current variances from those rates, or an explanation of other basis of estimates should be included. Where costs are based on allocation percentages or dollar rates, an explanation of rate and application base relationships should be given. For example, the base to which the General and Administrative (G&A) rate is applied could be explained as: application base equals total costs before G&A less subcontracts. All awards made as a result of this NRA maybe funded as grants or contracts. However, while proposals submitted by “for profit” organizations are allowed, they cannot include a “fee.”

- (11) Appendices, if any (**reviewers are not required to consider information presented in appendices**)
- (12) One (1) signed original and twenty (20) copies of the proposal cover page and the proposals must be received by **4:30 p.m., November 25, 2002**, at the following address:

NASA Peer Review Services
SUBJECT: 02-OBPR-02 Space Radiation Research Proposal
500 E Street SW
Suite 200
Washington, DC 20024
(202) 479-9030

II. Proposal Evaluation and Awards Selection Process

The following information is specific to this NRA and **supersedes** the information contained in paragraphs (i) and (j) of “Instructions for Responding to NASA Research Announcements.”

A. Compliance Matrix

All proposals must comply with the general requirements of the Announcement as described in both Appendices B and “Instructions for Responding to NASA Research Announcements.” Appendix B contains specific requirements and explanations for each section of the proposal above and beyond NASA-specified requirements. “Instructions for Responding to NASA Research Announcements” outlines the NASA-specified requirements for proposal submission and should be used for clarification and reference. Upon receipt, proposals will be reviewed for compliance with the requirements of this Announcement. This includes

1. Submission of complete proposals specified in this Announcement. Proposals must be responsive to the areas of program element emphasis described in this Announcement and include a project description that is not more than 20 pages in length.
2. Submission of appropriate Institutional Review Board (IRB) or Animal Care and Use Committee (ACUC) certification for all proposals using human or animal test subjects.
3. Submission of a budget that is within the guidelines specified in this Announcement and is for a funding period not exceeding that described in the Announcement.
4. Proposals that are revised versions of proposals previously submitted to NASA must be clearly designated as such on the proposal cover page and must contain an explanation of how the revised proposal has addressed criticisms from previous NASA review. This explanation should be presented in a separate section of **no more than two pages at the beginning of the project description** and is in addition to the 20 pages allowed for the project description. Related changes to the research plan should be highlighted in the body of the project description.
5. Submission of all other appropriate information as required by this NASA Research Announcement (refer to Section I, Appendix B).

Note: At NASA's discretion, non-compliant proposals may be withdrawn from the review process and returned to the investigator without further review.

Compliant proposals submitted in response to this Announcement will undergo an intrinsic scientific or technical merit review. Only those proposals most highly rated in the merit review process will undergo additional reviews for program relevance and cost.

B. Intrinsic Scientific or Technical Merit Review and Evaluation Criteria

The **first review tier** will be a merit review by a panel of scientific or technical experts. The number and diversity of experts required will be determined by the response to this NRA and by the variety of disciplines represented in the proposals relevant to the research emphases described in Appendix A. The merit review panel will assign **a score from 0-100** based upon the intrinsic scientific or technical merit of the proposal. This score will reflect the consensus of the panel.

The score assigned by this panel ***will not be affected by the cost of the proposed work nor will it reflect the programmatic relevance of the proposed work to NASA.*** However, the panel will be asked to include in their critique of each proposal any comments they may have concerning the proposal's budget and relevance to NASA.

All of the following criteria, of equal value, will be used in determining the merit score:

- **Significance:** Does this study address an important problem? If the aims of the application are achieved, how will scientific knowledge or technology be advanced? What will be the effect of these studies on the concepts, methods, or products that drive this field? Is there a significant societal or economic impact?

- **Approach:** Are the conceptual framework, design, methods, and analyses adequately developed, well integrated, and appropriate to the aims of the project? Is the proposed approach likely to yield the desired results? Does the applicant acknowledge potential problem areas and consider alternative tactics?
- **Innovation:** Does the project employ appropriate novel concepts, approaches, or methods? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technologies?
- **Investigator:** Is the investigator appropriately trained and well suited to carry out this work? Is the work proposed appropriate to the experience level of the principal investigator and any co-investigators? Is the evidence of the investigator's productivity satisfactory?
- **Environment:** Does the scientific environment in which the work will be performed contribute to the probability of success? Do the proposed experiments take advantage of unique features of the scientific environment or employ useful collaborative arrangements? Is there evidence of institutional support?

C. Evaluation of Programmatic Relevance and Cost

The **second review** will evaluate the programmatic relevance and cost of all proposed work. This review will be conducted by NASA Program Scientists and Managers. Evaluation of the cost of a proposed effort includes consideration of the realism and reasonableness of the proposed cost and the relationship of the proposed cost to available funds. Programmatic relevance will include an evaluation of how the proposed work may help achieve an appropriate balance of scientific and technical tasks required by critical research issues faced by NASA and OBPR.

D. Development of Selection Recommendation

The most important element in the evaluation process is the merit review, which carries the highest weight in final evaluation and selection. The other factors are approximately equal in weight to each other.

The information resulting from these two levels of review, as described above, will be used to prepare a **selection recommendation** developed by NASA program scientists and managers for each of the program elements described in this Announcement. This recommendation will be based on:

1. The scientific or technical merit review score from the peer review panel.
2. The programmatic relevance.
3. The cost of each proposal.

This **selection recommendation** is the responsibility of the NASA program scientist(s). Selection for funding will be made by the Selection Official identified in the Summary and Supplemental Information Section of this NRA.

At the end of the selection process, each proposing organization is notified of its selection or nonselection status. NASA provides debriefings to those investigators who request one. The selection letters will include a statement indicating the selected organization's business office will be contacted by a NASA Contracting or Grant Officer, who is the only official authorized to obligate the Government, and a reminder that any costs incurred by the investigator in anticipation of an award are at their own risk. Selection notification will be made by a letter signed by the selection official.

The NASA Procurement Office will determine the type of award instrument, request further business data, negotiate the resultant action, and are the only personnel with the authority to obligate government funds.

NASA reserves the right to offer selection of only a portion of a proposal. In these instances, the investigator will be given the opportunity to accept or decline the offer.

III. Eligibility

All categories of institutions are eligible to submit proposals in response to this NRA, but only approved proposals from U.S. institutions will be selected for funding. Principal Investigators may collaborate with universities, Federal Government laboratories, the private sector, and state and local government laboratories. In all such arrangements, the applying entity is expected to be responsible for administering the project according to the management approach presented in the proposal.

The applying entity must have in place a documented base of ongoing high quality research in science and technology or in those areas of science and engineering clearly relevant to the specific programmatic objectives and research emphases indicated in this Announcement. Present or prior support by NASA of research or training in any institution or for any investigator is neither a prerequisite to submission of a proposal nor a competing factor in the selection process.

IV. Guidelines for International Participation

Guidelines for International Participation are detailed in paragraph I of Appendix D of this Announcement.

Export Control Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation. Foreign proposals and proposals including foreign participation must include a section discussing compliance with U.S. export laws and regulations, e.g., 22 CFR Parts 120-130 and 15 CFR Parts 730-774, as applicable to the circumstances surrounding the particular foreign participation. The discussion must describe in detail the proposed foreign participation and is to include, but not be limited to, whether or not the foreign participation may require the prospective investigator to obtain the prior approval of the Department of State or the

Department of Commerce via a technical assistance agreement or an export license, or whether a license exemption/exception may apply. If prior approvals via licenses are necessary, discuss whether the license has been applied for or if not, the projected timing of the application and any implications for the schedule. Information regarding U.S. export regulations is available at <http://www.pmdtc.org/> and <http://www.bxa.doc.gov/>. Investigators are advised that under U.S. law and regulations, spacecraft and their specifically designed, modified, or configured systems, components, and parts are generally considered “Defense Articles” on the United States Munitions List and are subject to the provisions of the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120-130.

V. Program Reporting

It is expected that results from funded research will be submitted to peer-reviewed journals as the work progresses. Only published papers that acknowledge NASA’s support and identify the grant or contract will be counted as resulting from the research project and used to evaluate its productivity.

Annual Reporting. The Office of Biological and Physical Research publishes a comprehensive annual document titled OBPR Program Tasks and Bibliography (Task Book) which includes descriptions of all peer-reviewed activities funded by the division during the previous fiscal year. Since its inception, the Task Book has served as an invaluable source of information for OBPR as well as the scientific and technical communities.

Investigators are required to provide NASA with this annual summary information. This information will be made available to the scientific community and will be used to assess the strength of the Division’s programs. It will also serve as the basis for determining the degree of progress of the project. The information provided for the Task Book will meet the requirements for annual reporting requirements and the task book. This report will be due 60 days prior to the anniversary date of the grant start date.

The information requested will include

- an abstract
- a brief statement of progress during the fiscal year
- a brief statement of benefits of the research with respect to life on Earth
- a bibliographic list for the fiscal year
- a copy or reprint of each publication listed in the bibliography for the fiscal year
- a listing of presentations or activities conducted at 6-12 educational institutions
- a listing of interactions, presentations, or other activities with the general public
- copies of publications
- a statement of progress
- potential scientific, technological, economic or societal impact

Note that although this publication will be made available to the general scientific community, it is not a substitute for traditional scientific reporting in journals and elsewhere.

All articles submitted for publication must include the following statement: “This research was funded in whole or in part by a grant from the Office of Biological and Physical Research of the National Aeronautics and Space Administration.” Publications not including this acknowledgement will not be considered to be the product of NASA-funded research when NASA assesses the progress of the grant.

Final Report A final report is required that shall include all peer-reviewed publications.

VI. Support of Education and Public Outreach

OBPR envisions that the selected proposals will be structured and operated in a manner that supports the nation’s educational initiatives and goals (including support of historically black colleges and universities and other minority universities), and in particular the need to promote scientific and technical education at all levels. OBPR envisions that the selected proposals will support the goals for public awareness and outreach to the general public (see Announcement Section). The selected principal investigators are invited to participate in OBPR-funded educational programs.

OBPR Policy for Education (Grades 6-12) and Public Outreach

The proposal represents an opportunity for NASA to enhance and broaden the public’s understanding and appreciation of the value of OBPR research in the context of NASA’s mission. Therefore, all investigators are strongly encouraged to promote general scientific literacy and public understanding of OBPR research through formal and/or informal education opportunities. If appropriate, proposals should include a clear and concise description of the education and outreach activities proposed. Examples include such items as involvement of students in the research activities, technology transfer plans, public information programs that will inform the general public of the benefits being gained from the research, and/or plans for incorporation of scientific results obtained into educational curricula consistent with educational standards.

Where appropriate, the supported institution will be required to produce, in collaboration with NASA, a plan for communicating to the public the value and importance of their work. Once NRA selections are made, the selected PIs will have an opportunity to request additional funding through an OBPR-sponsored pilot program to implement an education outreach program at the grades 6-12 level, at an amount not to exceed \$10,000 per year for the term of the grant. A request for proposal will accompany the selection notification letter. Proposals will be due within 60 days of selection notification and shall be limited to 4 pages. A review of these proposals by educational specialists will determine which proposals will be funded.

VII. References

A. General References

GUIDEBOOK FOR PROPOSERS RESPONDING TO A NASA RESEARCH ANNOUNCEMENT (NRA):

<http://www.hq.nasa.gov/office/procurement/nraguidebook/gdbkcvr.html>. Although the Guidebook is currently being updated, it offers features like NRA FAQs that proposers may find useful.

OBPR Program Tasks and Bibliography (Task Book) for FY 1995 through FY 2000 are available online at the following address:

<http://research.hq.nasa.gov/taskbook.cfm>

Space Life Sciences Ground Facilities Information Package. This document is available online at the following address:

http://research.hq.nasa.gov/code_u/nra/current/NRA-02-OBPR-02/index.html

Life sciences research publications: **<http://spaceline.usuhs.mil>**, and **<http://www.nlm.nih.gov>**. Additional information may be obtained from the SPACELINE Project (phone: (301) 295-2482; e-mail: spaceline@usuhs.mil)

National Academy of Science. National Research Council Committee on Space Biology and Medicine. Mary J. Osborn, Committee Chairperson. **A Strategy for Research in Space Biology and Medicine in the New Century**. 1998. Washington D.C: National Academy Press. Web address: **<http://www.nas.edu/ssb/csbm1.html>**

A. Nicogossian, C. Huntoon, and S. Pool. (Eds.) **Space Physiology and Medicine**, 3rd ed. Lea & Febiger. Philadelphia, PA (1994).

FASEB Journal, Vol. 13, Supplement, **Cell & Molecular Biology Research in Space**. (1999). *Brain Research Reviews*, **Space Neuroscience Research**. Volume 28, Numbers 1/2, Special Issue, (1998).

NASA Space Radiation Health Program:

http://spaceresearch.nasa.gov/common/docs/radiation_strat_plan_1998.pdf

Space Radiation Health Project at Johnson Space Center: **<http://srhp.jsc.nasa.gov/>**

B. Selected Radiation References

Alpen, E.L., Powers-Risius, P., Curtis, S.B., and DeGuzman, R. Tumorigenic potential of high-Z, high-LET charged particle irradiations. *Radiat. Res.* 88, 132-143 (1993).

Blakely, E.A., Bjornstad, K.A., Chang, P.Y., McNamara, M.P., Chang, E., Aragon, G., Lin, S.P.,

Lui, G., and Polansky, J.R. Growth and differentiation of human lens epithelial cells in vitro on matrix. *Inv. Opth. & Vis. Sci.* 41, 3898-3907 (1999).

Cucinotta, F. A., W. Schimmerling, J. W. Wilson, L. E. Peterson, G. Badhwar, P. Saganti, and J. Dicello. Space Radiation Cancer Risks and Uncertainties for Mars Missions. *Radiat. Res.* 156: (2001)156, 682–688.

Cucinotta, F. A., F.K. Manuel, J. Jones, G. Iszard, J. Murrey, B. Djojonegro, and M. Wear. Space Radiation and Cataracts in Astronauts. *Radiat. Res.* 156: 460-466 (2001).

Cucinotta, F.A., Nikjoo, H., and Goodhead, D.T. The effects of delta rays on the number of particle-track traversals per cell in laboratory and space exposures. *Radiat. Res.* 150, 115-119 (1998).

Cucinotta, F.A., Wilson, J.W., Williams, J.R., and Dicello, J.F. Analysis of Mir-18 results for physical and biological dosimetry: radiation shielding effectiveness in *LEO*. *Radiat. Meas.* **31**, 181-191 (2000).

Ernhart, E.J., E.L. Gillette, E.L., and Barcellos-Hoff, M.H. Immunohistochemical evidence for rapid extracellular matrix remodeling after iron-particle irradiation of mouse mammary gland. *Radiat. Res.* 145, 157-162 (1996).

Fry R.J.M., Powers-Risius P., Alpen E.L., Ainsworth, E.J. High LET radiation carcinogenesis. *Radiat. Res.* 104, S188-195 (1985).

Goodhead, D.T. Initial events in the cellular effects of ionizing radiations: clustered damage in DNA. *Int. J. Radiat. Biol.* **65**, 7-17 (1994).

Joseph, J.A., Hunt, W.A., Rabin, B.M., Dalton, T.K. Possible accelerated aging induced by ⁵⁶Fe heavy particle irradiation: Implications for manned space flights. *Radiat. Res.* 130, 88-93 (1992).

National Council on Radiation Protection and Measurements (NCRP). Guidance on Radiation Received in Space Activities. Report 98. Washington, DC (1989)

National Council on Radiation Protection and Measurements (NCRP). Uncertainties in Fatal Cancer risk Estimates Used in Radiation Protection. Report 126. Washington, DC (2000)

National Council on Radiation Protection and Measurements (NCRP). Radiation Protection Guidance for Activities in Low-Earth Orbit. Report 132. Washington, DC (2000).

National Research Council. Radiation Hazards to Crews of Interplanetary Missions: Biological Issues and Research Strategies. National Academy Press, Washington, DC (1996)

National Research Council. Radiation and the International Space Station. National Academy Press, Washington, DC (2000).

Schimmerling, W. Space and radiation protection: scientific requirements for space research. Radiat. Environ. Biophys. 34: 133-137 (1995).

Zeitlin, C., J. Miller, L. Heilbronn, K. Frankel, W. Gong and W. Schimmerling, The Fragmentation of 510 MeV/Nucleon Iron-56 in Polyethylene. I. Fragment Fluence Spectra. Radiat. Res. 145: 655-665 (1996).

Zeitlin, C., L. Heilbronn, J. Miller W. Schimmerling, L. W. Townsend, R.K. Tripathi, and J. Wilson The Fragmentation of 510 MeV/Nucleon Iron-56 in Polyethylene. II. Comparisons between Data and a Model. Radiat. Res. 145: 666-672 (1996).

C. Selected Workshop Reports

Modeling Human Risk: Cell & Molecular Biology in Context. June, 1997. Ernest Orlando Lawrence Berkeley National Laboratory Report LBNL-40278. Berkeley, CA

International Space Life Sciences Working Group on Radiation Biology. Banff, Canada, November 1997. Mutation Res., 430: No. 2 (1999)

Models for Evaluation of Radiation Risk Factors. Radiat. Res. 156: Number 5, Part 2. November, 2001.

Second International Workshop on Space Radiation Research and 13th Annual NASA Space Radiation Health Investigators' Workshop, March 10-15, 2002, Nara, Japan:
<http://www.nirs.go.jp/usr/workshop/index.htm>

D. Selected Radiation Web Sites

Loma Linda University/NASA Radiobiology Program: **<http://www.llu.edu/llu/ci/nasa/>**

NASA activities at Brookhaven National Laboratory:
<http://www.bnl.gov/medical/NASA/NASA-home%20frame.htm>

NASA Specialized Center of Research and Training at Lawrence Berkeley Laboratory:
<http://www.lbl.gov/lifesciences/NSCORT/>

**CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER
RESPONSIBILITY MATTERS**

PRIMARY COVERED TRANSACTIONS

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 14 CFR Part 1269.

A. The applicant certifies that it and its principals:

- (a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
- (b) Have not within a three-year period preceding this application been convicted or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
- (c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph A.(b) of this certification; and
- (d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default; and

B. Where the applicant is unable to certify to any of the statements in this certification, he or she shall attach an explanation to this application.

C. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lowered Tier Covered Transactions (Subgrants or Subcontracts)

- a) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principles is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any federal department of agency.
- b) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

CERTIFICATION REGARDING LOBBYING

As required by S 1352 Title 31 of the U.S. Code for persons entering into a grant or cooperative agreement over \$100,000, the applicant certifies that:

- (a) No Federal appropriated funds have been paid or will be paid by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, in connection with making of any Federal grant, the entering into of any cooperative, and the extension, continuation, renewal, amendment, or modification of any Federal grant or cooperative agreement;
- (b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting an officer or employee of any agency, Member of Congress, an or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
- (c) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subgrants, contracts under grants and cooperative agreements, and subcontracts), and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by S1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

**CERTIFICATION OF COMPLIANCE WITH THE NASA REGULATIONS PURSUANT
TO
NONDISCRIMINATION IN FEDERALLY ASSISTED PROGRAMS**

The (Institution, corporation, firm, or other organization on whose behalf this assurance is signed, hereinafter called "Applicant") hereby agrees that it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), Title IX of the Education Amendments of 1962 (20 U.S. 1680 et seq.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S. 794), and the Age Discrimination Act of 1975 (42 U.S. 16101 et seq.), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250) (hereinafter called "NASA") issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participating in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives federal financial assistance from NASA; and hereby give assurance that it will immediately take any measure necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which the federal financial assistance is extended to it by NASA.

This assurance is given in consideration of and for the purpose of obtaining any and all federal grants, loans, contracts, property, discounts, or other federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for federal financial assistance which were approved before such date. The Applicant recognized and agrees that such federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and the United States shall have the right to seek judicial enforcement of this assurance. His assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign on behalf of the Applicant.

**INSTRUCTIONS FOR RESPONDING TO NASA RESEARCH
ANNOUNCEMENTS**

(MAY 2002)

(a) General.

(1) Proposals received in response to a NASA Research Announcement (NRA) will be used only for evaluation purposes. NASA does not allow a proposal, the contents of which are not available without restriction from another source, or any unique ideas submitted in response to an NRA to be used as the basis of a solicitation or in negotiation with other organizations, nor is a pre-award synopsis published for individual proposals.

(2) A solicited proposal that results in a NASA award becomes part of the record of that transaction and may be available to the public on specific request; however, information or material that NASA and the awardee mutually agree to be of a privileged nature will be held in confidence to the extent permitted by law, including the Freedom of Information Act.

(3) NRAs contain programmatic information and certain requirements which apply only to proposals prepared in response to that particular announcement. These instructions contain the general proposal preparation information which applies to responses to all NRAs.

(4) A contract, grant, cooperative agreement, or other agreement may be used to accomplish an effort funded in response to an NRA. NASA will determine the appropriate award instrument. Contracts resulting from NRAs are subject to the Federal Acquisition Regulation and the NASA FAR Supplement. Any resultant grants or cooperative agreements will be awarded and administered in accordance with the NASA Grant and Cooperative Agreement Handbook (NPG 5800.1).

(5) NASA does not have mandatory forms or formats for responses to NRAs; however, it is requested that proposals conform to the guidelines in these instructions. NASA may accept proposals without discussion; hence, proposals should initially be as complete as possible and be submitted on the proposers' most favorable terms.

(6) To be considered for award, a submission must, at a minimum, present a specific project within the areas delineated by the NRA; contain sufficient technical and cost information to permit a meaningful evaluation; be signed by an official authorized to legally bind the submitting organization; not merely offer to perform standard services or to just provide computer facilities or services; and not significantly duplicate a more specific current or pending NASA solicitation.

(b) **NRA-Specific Items.** Several proposal submission items appear in the NRA itself: the unique NRA identifier; when to submit proposals; where to send proposals; number of copies required; and sources for more information. Items included in these instructions may be supplemented by the NRA.

(c) The following information is needed to permit consideration in an objective manner. NRAs will generally specify topics for which additional information or greater detail is desirable. Each proposal copy shall contain all submitted material, including a copy of the transmittal letter if it contains substantive information.

(1) Transmittal Letter or Prefatory Material.

(i) The legal name and address of the organization and specific division or campus identification if part of a larger organization;

(ii) A brief, scientifically valid project title intelligible to a scientifically literate reader and suitable for use in the public press;

(iii) Type of organization: e.g., profit, nonprofit, educational, small business, minority, women-owned, etc.;

(iv) Name and telephone number of the principal investigator and business personnel who may be contacted during evaluation or negotiation;

(v) Identification of other organizations that are currently evaluating a proposal for the same efforts;

(vi) Identification of the NRA, by number and title, to which the proposal is responding;

(vii) Dollar amount requested, desired starting date, and duration of project;

(viii) Date of submission; and

(ix) Signature of a responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization (unless the signature appears on the proposal itself).

(2) Restriction on Use and Disclosure of Proposal Information. Information contained in proposals is used for evaluation purposes only. Offerors or quoters should, in order to maximize protection of trade secrets or other information that is confidential or privileged, place the following notice on the title page of the proposal and specify the information subject to the notice by inserting an appropriate identification in the notice. In any event, information contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

Notice

Restriction on Use and Disclosure of Proposal Information

The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(3) **Abstract.** Include a concise (200-300 word if not otherwise specified in the NRA) abstract describing the objective and the method of approach.

(4) **Project Description.**

(i) The main body of the proposal shall be a detailed statement of the work to be undertaken and should include objectives and expected significance; relation to the present state of knowledge; and relation to previous work done on the project and to related work in progress elsewhere. The statement should outline the plan of work, including the broad design of experiments to be undertaken and a description of experimental methods and procedures. The project description should address the evaluation factors in these instructions and any specific factors in the NRA. Any substantial collaboration with individuals not referred to in the budget or use of consultants should be described. Subcontracting significant portions of a research project is discouraged.

(ii) When it is expected that the effort will require more than one year, the proposal should cover the complete project to the extent that it can be reasonably anticipated. Principal emphasis should be on the first year of work, and the description should distinguish clearly between the first year's work and work planned for subsequent years.

(5) **Management Approach.** For large or complex efforts involving interactions among numerous individuals or other organizations, plans for distribution of responsibilities and arrangements for ensuring a coordinated effort should be described.

(6) **Personnel.** The principal investigator is responsible for supervision of the work and participates in the conduct of the research regardless of whether or not compensated under the award. A short biographical sketch of the principal investigator, a list of principal publications and any exceptional qualifications should be included. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants,

together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

(7) Facilities and Equipment.

(i) Describe available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any Government-owned facilities, industrial plant equipment, or special tooling that are proposed for use. Include evidence of its availability and the cognizant Government points of contact.

(ii) Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for research and non-research purposes should be explained.

(8) Proposed Costs (U.S. Proposals Only).

(i) Proposals should contain cost and technical parts in one volume: do not use separate "confidential" salary pages. As applicable, include separate cost estimates for salaries and wages; fringe benefits; equipment; expendable materials and supplies; services; domestic and foreign travel; ADP expenses; publication or page charges; consultants; subcontracts; other miscellaneous identifiable direct costs; and indirect costs. List salaries and wages in appropriate organizational categories (e.g., principal investigator, other scientific and engineering professionals, graduate students, research assistants, and technicians and other non-professional personnel). Estimate all staffing data in terms of staff-months or fractions of full-time.

(ii) Explanatory notes should accompany the cost proposal to provide identification and estimated cost of major capital equipment items to be acquired; purpose and estimated number and lengths of trips planned; basis for indirect cost computation (including date of most recent negotiation and cognizant agency); and clarification of other items in the cost proposal that are not self-evident. List estimated expenses as yearly requirements by major work phases.

(iii) Allowable costs are governed by FAR Part 31 and the NASA FAR Supplement Part 1831 (and OMB Circulars A-21 for educational institutions and A-122 for nonprofit organizations).

(iv) Use of NASA funds--NASA funding may not be used for foreign research efforts at any level, whether as a collaborator or a subcontract. The direct purchase of supplies and/or services, which do not constitute research, from non-U.S. sources by U.S. award recipients is permitted. Additionally, in accordance with the National Space Transportation Policy, use of a non-U.S. manufactured launch vehicle is permitted only on a no-exchange-of-funds basis.

(9) Security. Proposals should not contain security classified material. If the research

requires access to or may generate security classified information, the submitter will be required to comply with Government security regulations.

(10) **Current Support.** For other current projects being conducted by the principal investigator, provide title of project, sponsoring agency, and ending date.

(11) **Special Matters.**

(i) Include any required statements of environmental impact of the research, human subject or animal care provisions, conflict of interest, or on such other topics as may be required by the nature of the effort and current statutes, executive orders, or other current Government-wide guidelines.

(ii) Proposers should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. Identify the cognizant Government audit agency, inspection agency, and administrative contracting officer, when applicable.

(d) **Renewal Proposals.**

(1) Renewal proposals for existing awards will be considered in the same manner as proposals for new endeavors. A renewal proposal should not repeat all of the information that was in the original proposal. The renewal proposal should refer to its predecessor, update the parts that are no longer current, and indicate what elements of the research are expected to be covered during the period for which support is desired. A description of any significant findings since the most recent progress report should be included. The renewal proposal should treat, in reasonable detail, the plans for the next period, contain a cost estimate, and otherwise adhere to these instructions.

(2) NASA may renew an effort either through amendment of an existing contract or by a new award.

(e) **Length.** Unless otherwise specified in the NRA, effort should be made to keep proposals as brief as possible, concentrating on substantive material. Few proposals need exceed 15-20 pages. Necessary detailed information, such as reprints, should be included as attachments. A complete set of attachments is necessary for each copy of the proposal. As proposals are not returned, avoid use of "one-of-a-kind" attachments.

(f) **Joint Proposals.**

(1) Where multiple organizations are involved, the proposal may be submitted by only one of them. It should clearly describe the role to be played by the other organizations and indicate the legal and managerial arrangements contemplated. In other instances, simultaneous submission of related proposals from each organization might be appropriate, in which case parallel awards would be made.

(2) Where a project of a cooperative nature with NASA is contemplated, describe the

contributions expected from any participating NASA investigator and agency facilities or equipment which may be required. The proposal must be confined only to that which the proposing organization can commit itself. "Joint" proposals which specify the internal arrangements NASA will actually make are not acceptable as a means of establishing an agency commitment.

(g) **Late Proposals.** Proposals or proposal modifications received after the latest date specified for receipt may be considered if a significant reduction in cost to the Government is probable or if there are significant technical advantages, as compared with proposals previously received.

(h) **Withdrawal.** Proposals may be withdrawn by the proposer at any time before award. Offerors are requested to notify NASA if the proposal is funded by another organization or of other changed circumstances which dictate termination of evaluation.

(i) **Evaluation Factors.**

(1) Unless otherwise specified in the NRA, the principal elements (of approximately equal weight) considered in evaluating a proposal are its relevance to NASA's objectives, intrinsic merit, and cost.

(2) Evaluation of a proposal's relevance to NASA's objectives includes the consideration of the potential contribution of the effort to NASA's mission.

(3) Evaluation of its intrinsic merit includes the consideration of the following factors of equal importance:

(i) Overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

(ii) Offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.

(iii) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives.

(iv) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

(4) Evaluation of the cost of a proposed effort may include the realism and reasonableness of the proposed cost and available funds.

(j) **Evaluation Techniques.** Selection decisions will be made following peer and/or scientific review of the proposals.. Several evaluation techniques are regularly used within NASA. In all cases proposals are subject to scientific review by discipline specialists in the area of the proposal. Some proposals are reviewed entirely in-house, others are evaluated by a combination of in-house and selected external reviewers, while yet others are subject to the full external peer review technique (with due regard for conflict-of-interest and

protection of proposal information), such as by mail or through assembled panels. The final decisions are made by a NASA selecting official. A proposal which is scientifically and programmatically meritorious, but not selected for award

during its initial review, may be included in subsequent reviews unless the proposer requests otherwise.

(k) Selection for Award.

(1) When a proposal is not selected for award, the proposer will be notified. NASA will explain generally why the proposal was not selected. Proposers desiring additional information may contact the selecting official who will arrange a debriefing.

(2) When a proposal is selected for award, negotiation and award will be handled by the procurement office in the funding installation. The proposal is used as the basis for negotiation. The contracting officer may request certain business data and may forward a model award instrument and other information pertinent to negotiation.

(l) Additional Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation.

(1) NASA welcomes proposals from outside the U.S. However, foreign entities are generally not eligible for funding from NASA. Therefore, unless otherwise noted in the NRA, proposals from foreign entities should not include a cost plan unless the proposal involves collaboration with a U.S. institution, in which case a cost plan for only the participation of the U.S. entity must be included. Proposals from foreign entities and proposals from U.S. entities that include foreign participation must be endorsed by the respective government agency or funding/sponsoring institution in the country from which the foreign entity is proposing. Such endorsement should indicate that the proposal merits careful consideration by NASA, and if the proposal is selected, sufficient funds will be made available to undertake the activity as proposed.

(2) All foreign proposals must be typewritten in English and comply with all other submission requirements stated in the NRA. All foreign proposals will undergo the same evaluation and selection process as those originating in the U.S. All proposals must be received before the established closing date. Those received after the closing date will be treated in accordance with paragraph (g) of this provision. Sponsoring foreign government agencies or funding institutions may, in exceptional situations, forward a proposal without endorsement if endorsement is not possible before the announced closing date. In such cases, the NASA sponsoring office should be advised when a decision on endorsement can be expected.

(3) Successful and unsuccessful foreign entities will be contacted directly by the NASA sponsoring office. Copies of these letters will be sent to the foreign sponsor. Should a foreign proposal or a U.S. proposal with foreign participation be selected, NASA's Office of External Relations will arrange with the foreign sponsor for the proposed participation on a no-exchange-of-funds basis, in which NASA and the non-

U.S. sponsoring agency or funding institution will each bear the cost of discharging their respective responsibilities.

(4) Depending on the nature and extent of the proposed cooperation, these arrangements may entail:

(i) An exchange of letters between NASA and the foreign sponsor; or

(ii) A formal Agency-to-Agency Memorandum of Understanding (MOU).

(m) **Cancellation of NRA.** NASA reserves the right to make no awards under this NRA and to cancel this NRA. NASA assumes no liability for canceling the NRA or for anyone's failure to receive actual notice of cancellation.